

SOUND DEADENING IN HOSPITALS

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NOISE in any form is obviously objectionable about a hospital; whether or not it is caused by the slamming of doors, the operation of the elevators or ventilating machinery, or by persons walking, by conversation, or by a patient in pain. Complaints regarding this annoyance are heard about almost every hospital to a greater or less extent; probably more today than years ago before the use of fire-resisting construction was so general.

Quiet in hospitals is not a matter of architectural acoustics, which are determined by the form and furnishings of rooms. The acoustics of halls, theaters, etc., are among the rational engineering problems and perfect acoustical qualities, that is, perfect hearing by every listener can be predetermined; in hospitals, however, the problem is quite another matter.

The floors, partitions, and walls of buildings of combustible construction, which appear to be less noisy, are constructed of many pieces and have interior air spaces. Building felts and other combustible materials are used. Such construction is not permissible in fire-resisting construction, except to a minor extent. The numerous air spaces, which help in preventing the passage of sound, form flues and shafts which accelerate the travel of fire.

Fire-resisting construction of any kind is practically vermin-proof, and does not contain the

numerous continuous air spaces which afford runways for mice and rats and, therefore, has another point in its favor over combustible construction.

The older form of fire-resisting construction, viz., structural steel beams and hollow tiles, also contained many air spaces. This construction was also fairly sound-proof. With the advent of reinforced concrete construction and the use of a very few hard materials, buildings were soon found to be unusually noisy. The first concrete buildings had solid floor slabs with finished cement floor surfaces and plaster on the under or ceiling side. Therefore, in substance, there was only one material, sometimes only a few inches in thickness, between two stories; hence, sound was easily transmitted from one floor to the other. The so-called sanitary floors, such as magnesia composition, terrazzo, and tile, are also dense and comparatively thin, so that their use does not decrease the travel of sound to any considerable extent when used on such construction.

Newer forms of reinforced concrete construction, in combination with hollow clay tile, gypsum

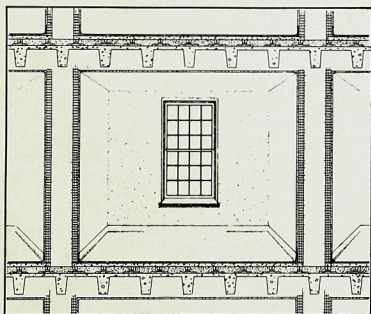


Fig. 1. Cross section of ideal construction.



Fig. 2. Diagonal view of one of the Evanston sound-proof doors.

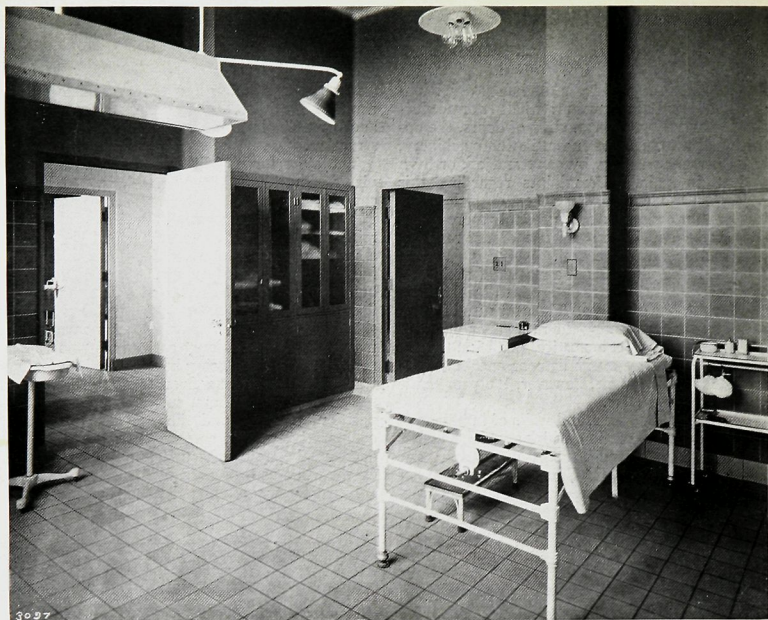


Fig. 3. Chicago Lying-In Hospital, birth room. The doors on the left and right are sound proof. Note thickness and lever handles.

domes, or steel forms which require suspended metal lath and plaster ceilings, provide additional air spaces, which better the condition. Such forms of construction, when used in hotels and apartment houses, are quite satisfactory because of the use of carpets, rugs, and heavy padding under the carpets. Reinforced concrete construction is considerably cheaper than hollow tile and steel, and has almost completely supplanted the latter, because of the greatly enhanced cost of building.

The problem of sound insulation or elimination is a difficult one, and it is necessary to provide sound-absorbing materials. For complete insulation the deadening material must be so thick as to be prohibitive, although relatively thin layers produce an appreciable reduction in intensity of sound transmitted.

Complete absorption of sound, or the prevention of its travel from one room to another, would

probably require an arrangement consisting of finished rooms completely insulated or separated from the rooms adjoining on the sides, from the corridors and from the rooms above and below. Such an arrangement may be viewed by conceiving a complete building with all unfinished walls, floors, and partitions in place with another finished set of rooms within the rough structure but not in contact with it. Obviously this is impossible, for the inner finished floors, walls, and ceilings must be supported on the structural floors; but the floors, walls, and ceilings can be placed on sound-absorbing cushions, with sound-absorbing connections in doorways and windows. In this way a complete air space will be constructed around the room, as shown in Figure 1. Such an arrangement will not be sound-proof, however, unless the materials in the floors, partitions, and walls are of such a nature and thick-



Fig. 4. Chicago Lying-In Hospital.

ness that sound will not travel across the air spaces.

It is apparent that such a building will virtually consist of two buildings, i.e., it would require almost double the amount of material and labor, and cost twice as much as the ordinary building; its cost is consequently prohibitive.

The Wallace Clement Sabin Laboratory of Acoustics at Geneva, Illinois, was built to exclude all sound from one portion to another, except as it passes through a wall the transmission of which is being studied. The securing of this condition is exceedingly difficult and the building essentially consists of two entirely separate structures under a single roof. This, together with the fact that it was necessary to build it of massive concrete and brick construction probably made its cost unusually great in proportion to the space enclosed. Heavy steel and ice box doors were used in lieu of ordinary doors. These doors were placed on two sides of vestibules which function as sound locks. Possible transmission from room to room by a common floor construction made it necessary that the rooms be separated clear to the foundation. The walls of these rooms are of solid masonry 18 inches thick, and the foundations consist of successive layers of sand, hollow tile,

concrete, several layers of tarred paper, and a concrete wearing surface. Where contact was necessary, layers of felt were placed between adjoining walls, air spaces were left between walls, for, experience has shown that they afford more effective insulation than a reasonable thickness of felt or other absorbing material.

Pasteur's great discoveries were soon followed by a general demand for the use of impervious and non-shrinking materials for floors, walls, ceilings, and all other parts of a hospital, and labor costs required the use of materials which could be quickly and easily cleaned. This demand was met by manufacturers of all classes of building material by supplying dense hard plasters, enamel paints, glazed tiles, white glass, metal trim, metal doors, composition floors, terrazzo and tile floors, all of which excellently served the demand for easy and perfect cleansing; their use increased the difficulty for they have great sound-reflecting power and resist sound transmission very little. Consideration of only one of these materials, viz., wall plaster, will illustrate the effect of the demand. The old form of lime, sand, and hair or wood fiber was rather porous and absorbing but the modern cement wall plaster is much denser and harder, and hard glossy



Fig. 5. Michael Reese Hospital, exterior.

enamel paints increase its reflecting power and decrease its sound absorption.

Thick soft cartridge papers or Lincrusta Walton, or canvas covered felt may be suitable expedients in offices and homes, but are improper for hospital use.

Fire-resisting and sound-absorbing material which has an artistic appearance and which can be molded and ornamented to resemble coarse stone or terra cotta and made in thin slabs or blocks, is manufactured by the R. Guastavino Co., of New York. This material contains innumerable air cells and appears to consist of round grains resembling roe. It is eminently suitable for lobbies, entrances, chapels, and lecture halls, but too porous and expensive for general use in hospitals. It is easily soiled if used within 6 or 7 feet of the floor. Painting would decrease its absorbing power and destroys its natural pleasing color which requires no further finish for ornamental purposes.

To build complete partitions, walls and floors of sound-absorbing material of high efficiency is impracticable on account of expense or combustibility and in some cases structurally. It, therefore, appears necessary to build the structure and partitions of the materials generally used, which are the cheapest for building purposes, and to interline these building elements with layers or diaphragms of absorbing material which will produce an appreciable reduction in the intensity of the sound transmission.

Felt, felt paper, mineral wool, asbestos, and cork, all of which contain minute air cells, are quite effective. Any of these can be used in floors and covered on the wearing surfaces by tile, terrazzo, cement, etc., but it is difficult to use any of them except cork in connection with walls or partitions, for it is obvious that it would be necessary to build hollow partitions, the cost of which is usually double that of the single partition. Inasmuch as wall plaster and cement will adhere to cork and cork can be applied to one

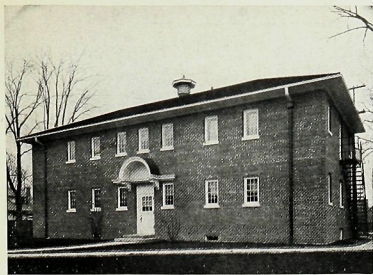


Fig. 6. Piano Practice Hall of Northwestern University School of Music.

side of a partition or the underside of a ceiling, against walls and on floors, this material in the form of compressed sheets, appears to be the most suitable and reasonable in cost. It has been used successfully for all sides of operating, delivery, and labor rooms, and after the plastering and floor surfaces were applied their appearance does not differ from the ordinary tiled and plastered room.

Further to confine and absorb sound originating in these rooms, special sound-proof doors are used. These doors are built up of two thin wooden doors joined by small metal spacers forming an air space partially filled by a thick sheet of felt. The space between the two doors also contains a parallelogram of steel bars operated by the lever handle of the latch, which presses strips of compressed felt against the three sides of the frame and the floor when the door is closed and the lever is pushed downward, and simultaneously engages the door latch with the strike plate. Such doors are made under patents of Irving Hamlin, of Evanston, Illinois, and have functioned satisfactorily in Michael Reese Hospital and Lying-In Hospital, Chicago, and the Piano Practice Hall of Northwestern University School of Music (Figs. 2, 3, 4, 5, and 6).

This is a superior door for telephone booths, and inasmuch as it hermetically seals the opening it can also be used to advantage for vapor bath rooms, for communicating doors of suites and bath rooms and to facilitate fumigation or disinfection.

Nalecod, a proprietary combination of powdered and fibrous materials mixed with Portland cement, sand, and water, makes a plastic mortar that sets and forms a tough elastic mass filled with air cells, into which nails or screws can be

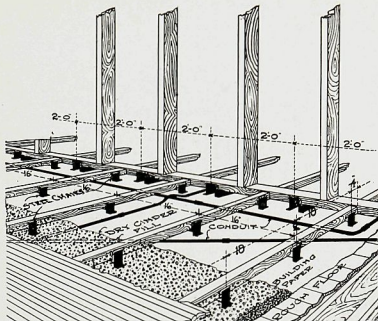


Fig. 7. Perspective of Stevens' system of floor deadening.

driven as rapidly as into wood. It is vermin-proof, fireproof, light, and quite sound-absorbing and furnishes an excellent base for flooring of all kinds. Its elasticity compensates the varying rates of expansion and contraction of the structure of a building and composition, terrazzo, mosaic, tile, and other forms of flooring, and is, therefore, a valuable additional building material.

Hardwood flooring, if laid on Nalecod, in pieces 16 or 18 inches in length, in herringbone pattern, and thoroughly finished with wax affords an excellent sound-absorbing floor, which will not shrink to such an extent that it will have open joints of the dimensions which has made wood flooring in its ordinary form objectionable for modern hospital use.

Stevens' system of floor deadening (Figs. 7, 8, and 9) has been unusually successful for use in apartment houses and hotels where wooden floors have been used, and inasmuch as a filling of dry cinders is used in lieu of the customary moist filling, containing cinder concrete, wood floors do not shrink to the same extent as they do when used on the older form of construction. It consists of small metal supports or chairs, which are bedded in cement mortar about 18 inches apart and support wood nailing strips in U-shaped recesses lined with felt. These strips, to which the flooring is nailed, are placed 16 inches from center to center. The space between and under the nailing strips is filled with a course of clean dry steam boiler cinders to a depth of about 3 inches. Partitions can also be supported on similar chairs and assist greatly in stopping the transmission of sound.

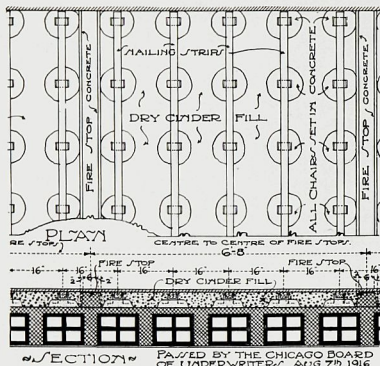


Fig. 8. Plan and section of Stevens' system of floor deadening on fireproof construction.

Elevator, ventilating, and other machinery should be placed in insulated rooms, on special pads formed of cork, wood, and felt in alternating layers or combinations of Stevens' padded chairs and strips which can be used in sufficient number to carry heavy machines.

Pumps, fans, vacuum pumps, and other machines should be connected to pipes and ducts by flexible rubber, felt or canvas connections, which ever may be the most suitable; these, and felt curtains hung in chambers in connection with large air ducts, will absorb sound which would otherwise be transmitted from the machinery to remote parts of the building.

The electric control of elevators need not be in spaces directly connected to the elevator shaft, but can be placed in insulated chambers at any convenient point, however distant from machine.

Noise caused by electric switches in making and breaking contacts is particularly penetrating, especially during the night when general noises do not prevail.

Elevator shafts should not open on room corridors, but, on a separate hall or entry, inasmuch as the noise caused by the latch of the metal shaft doors and of the elevator is difficult to eliminate.

Latches should be omitted on interior doors and they should be equipped with a good check and spring to close them noiselessly. If so arranged they can be pushed to open in one direction and if suitably shaped hooks are provided on the other side of the doors, they can be opened

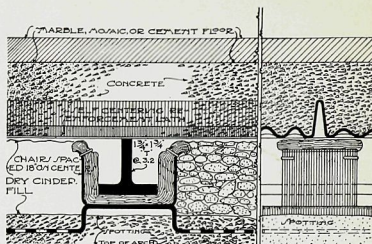


Fig. 9. Detail of Stevens' system of floor deadening on fireproof construction.

in the other direction by the forearm, which will permit a nurse to carry a tray or other similar article in both hands.

Corridors are magnified speaking tubes and sound will be reflected from walls, ceiling, and floor, first from one and then from another, losing some little sound at each reflection but usually continuing from end to end. Inasmuch as there are a comparatively small number of people in corridors, no draperies, and almost no pilasters or projections, and as the wall and ceiling surfaces and floors are hard, very little sound is absorbed.

Dividing their length by partitions would help but partitions of ordinary construction would obstruct light and are, therefore, not practical, but conditions can be bettered considerably by placing partitions of light steel and glass at intervals. These do not obstruct light and if the doors are wide, double acting, and the glass well protected by push bars they do not offer much obstruction to travel. Obviously any section of a corridor without windows should be ventilated by mechanical means.

Of all the floors in a hospital, the corridor floors require deadening the most. Not only should they be insulated to prevent the travel of sound to spaces under them but sound caused by walking should be absorbed before it can annoy patients on the same floor. Loose runners of rubber or matting are objectionable for obvious reasons and it is wasteful to cover a good tile or terrazzo floor; it, therefore, seems more advisable to arrange recesses in the hard materials of the same thickness as sound-absorbing materials, such as cork, rubber tile, linoleum, elastic tile, and to cement these solidly to a comparatively inexpensive Portland cement base, or on Nalecod. Borders of hard material are admissible and desirable on account of easy cleansing and attractive appearance.